MODULAR STRUCTURE FOR CONTAINING ARTICLES, FLUIDS OR PERSONS IN A STATE OF REST OR MOVEMENT

The present invention relates to a modular structure for containing articles, fluids or persons, in accordance with the introduction to the main claim.

Modular structures of the aforesaid type have been known for some time. They are generally arranged to contain liquids (for example water), in which case they define tanks, pools or the like; or are arranged to contain articles (such as mechanical products or products resulting from mechanical machining or from civil or industrial construction activities), in which case they define containing bins of the most varied dimensions; or are arranged to contain persons, in which case they define dwelling units. These modular structures, in particular those required to contain liquids or persons, must be constructed in such a manner as not to allow leakage of said liquids or the infiltration of fluids (liquids such as water or aeriforms such as environmental air) into the structure.

Known modular structures of the stated type generally comprise flat polygonal panels of plastic material (for example polyethylene) or composite material (for example plastic material containing glass fibres), which are joined together along their end edges by mechanical fixing members cooperating with end flanges present at said edges and projecting from a face of each panel on the outside of the interior compartment of the modular structure. To obtain the necessary fluid tightness, seal elements such as rubber gaskets or layers of silicone or polyurethane adhesive are inserted along and between facing edges of two adjacent panels.

The known solutions present various drawbacks. For example, as the modular structures are obtained from panels of polygonal shape (for example square or rectangular), the formed structures are of cubic or parallelepiped shape, so considerably limiting their use: for example a water tank cannot be formed on a roof if the roof is not completely free of chimney caps or dormer windows, i.e. if the roof does not comprise a completely flat surface without projections. Consequently the shape of the panels used to construct such modular structures considerably limits the scope for forming structures with shapes

enabling them to be adapted to uses on surfaces not perfectly free from projecting objects.

Moreover the use of said panels, which results in the construction of modular structures having their interior compartment defined by walls which terminate at right angles (at the connection between the flat panels), does not enable tanks for drinking water or for water for agricultural use to be constructed as the interior compartment of the structure cannot be completely and reliably cleaned (when emptied) along the right angles present between its walls. It follows that at the connection regions between the walls, mould or fungi can form which can unacceptably contaminate the liquid contained in the tank.

To this must be added the fact that the modular structure obtained in accordance with the teachings of the known art is of difficult and laborious assembly in that, during assembly, each joint between adjacent panels requires the previous positioning of the seal element therebetween. Moreover if any fitting problem arises during the assembly of the modular structure, such that those panels already joined together have to be separated, this separation can be problematic or indeed impossible because of the seal element interposed between them, this seal element then being at least difficult to later reuse.

In addition, the known modular structures comprise mechanical coupling and connecting elements which are laborious to use, resulting in considerable time and cost in assembling the modular structure.

An object of the present invention is to provide a modular structure which offers considerable versatility in its use, which is easy to assembly, and which is simple to transport when in its non-assembled state.

Another object is to provide a structure of the stated type which can also be assembled in uncomfortable environments.

A further object is to provide a structure of the stated type which can contain fluids or articles in a state of rest or movement.

Another object is to provide a modular structure, the fluid tightness of which can be obtained after the structure has been mechanically assembled, hence enabling this tightness to be obtained independently of the assembly operations, hence achieving considerable assembly flexibility and a greater reliability in the use of the assembled structure.

Another object is to provide a modular structure of the stated type, the interior compartment of which, once emptied, can be completely and reliably cleaned, including along the regions at the joint between its walls, hence offering a high level of hygiene in the subsequent use of the structure which, for this reason, can for example be safely used as a tank for drinking water.

The present invention will be more apparent from the accompanying drawing, which is provided by way of non-limiting example and in which:

Figure 1 is a perspective view of a first structure according to the invention;

Figure 2 is a perspective view of a second structure according to the invention;

Figure 3 is a perspective view of an incomplete third structure according to the invention;

Figure 4 is a perspective view of an incomplete fourth structure according to the invention;

Figure 5 is a perspective view of an incomplete fifth structure according to the invention;

Figure 6 is a perspective view of a sixth structure according to the invention;

Figure 6A is a section on the line 6A-6A of Figure 6;

Figure 7 is a perspective view of an incomplete seventh structure according to the invention;

Figure 8 is a perspective view of the complete seventh structure according to the invention;

Figure 9 is a perspective view of an eighth structure according to the invention;

Figure 10 is an enlarged perspective view of the part indicated by A in Figure 8;

Figure 11 is a section on the line 11-11 of Figure 7.

With reference to the figures, these show various embodiments of a modular structure according to the invention. In particular, a structure of the stated type can define a tank (Figures 1, 2, 5), a conduit (usable as a pipe for the passage of solid bodies or fluids or as a passageway between dwelling units (Figures 3 and 4), an open-top tank or bin for containing fluids or solid bodies (Figure 6), or a pool (Figures 7 and 8). All these structures, as described hereinafter, comprise at least one element 1 having a curved surface of single curvature, his term (single curvature) meaning a surface the generators of which lie on the lateral surface of a cylinder of circular base, i.e. a surface generated by the

rotation of a segment about a fixed axis. This element 1 is coupled to similar or different elements.

According to the invention, the aforesaid structure can also be a dwelling unit.

Specifically, Figure 1 shows a first tank 10 substantially of parallelepiped shape and presenting various "faces" 2, 3, 4, 5, 6 and 7.

Figure 2 shows a second tank 20 of shape different from the first. In this figure, parts corresponding to those of Figure 1 are indicated by the same reference numerals. The tank of Figure 5 has another shape different from that of the tank of Figures 1 and 2 and presents elements with curved surfaces which are exposed, i.e. not covered by corresponding external closure panels visible in Figures 1 and 2; these closure panels have an aesthetic function and are used to cover the "bare" structure (such as that of Figure 5) after its various elements have been joined together. Bare (or "incomplete") structures are also shown in Figures 3, 4 and 7. As can be seen from these latter, the elements 1 (or "angular" elements) shown in them are positioned along the edges of the relative structures and are coupled to polygonal elements 13 (for example, in Figures 3 and 7) or are coupled directly together (Figures 4 and 5). In all the figures under examination (3, 4, 5 and 7), "corner" element 15 are also present comprising two adjacent curved surfaces connected together and with different centres of curvature 16 and 17 which enable each corner element 15 to define a "corner" of the structure to which it pertains.

As an alternative, in Figure 9 a plurality of elements 1 can be joined together to define a channel, for example a discharge channel.

It should be noted that for simplicity, the closure elements are indicated by the same reference numerals as the corresponding "bare" (i.e. uncovered) elements but with the addition of the letter A. This is because these closure elements have the same shape as the elements which they cover and are hence similar to them from the descriptive viewpoint.

The elements 1 and the adjacent elements (flat, angular or corner) to be coupled to them are joined together by fixing means comprising U-pieces 24 to be positioned over and along projecting flanges 25 provided in correspondence with free end edges 26 of each coupled element 1, 13 or 15, on that side 31 thereof which lies opposite the side 32 facing the cavity or interior compartment

28 of the respective structure. Flanges 25 of two adjacent and at least partly coplanar elements are coupled together and over them are fitted the U-pieces 24, which are fixed by mechanical fixing members such as bolts, nails or screws 34 passing through holes 35 provided in the flanges 25 and holes 36 provided in the U-pieces 24.

The coupled elements 1, 13 or 15 define the inner wall of the modular structure bounding the interior compartment 28 thereof. In this wall, in correspondence with the regions in which the adjacent coupled elements are joined together, there are defined, by end recesses 97 therein, seats 40 for containing means for sealing against fluids, i.e. against a liquid (for example water) contained in the compartment 28 or against environmental air external to this compartment if the structure is used as a dwelling unit. The seal means can be a deformable body, for example of silicone rubber, such as that shown in Figures 10 and 11 and indicated therein by 43, or can comprise bodies 43 associated with silicone, or simply suitable layers of silicone or polyurethane adhesives of known type. In this latter case the seal means also act as the final fixing means between the coupled elements after the modular structure has been assembled.

If the bodies 43 are used, these are coupled at at least one of their free ends 45 to cross-joint elements 46 to be positioned at the crossing regions 51 between the seats 40 of the coupled panels. Each joint element 46 comprises a plurality of arms 47, partly hollow at 48 and receiving the ends 45 of the bodies 43. These arms have a slightly tapered section and are flat on one of their faces 50. When inserted into a region 51, they deform and remain fixed within the region, with their flat face lying substantially coplanar with the inner wall of the modular structure.

To ensure the seal in correspondence with said regions 51, each joint element 46 has a through hole 460 in correspondence with the connection region 461 of the arms 47. This hole is connected to the cavities 48 of said arms. It is arranged to receive a fluid sealing and securing element (silicone type) that by penetrating into said cavities reaches the ends 45 of the bodies 43. When this element sets, it secures these ends to said joint element 46 and also closes all spaces within the cavities 48.

By virtue of this solution, each body 43 is made rigid with the corresponding joint element 46 and there is no risk of it separating with time, for example because of ageing of the material defining said bodies 43 and elements 46; this also enables take-up of the slack between said bodies and the arms 47 of said elements 46 deriving from imperfect coupling or installation of the parts.

If the structure contains a liquid, this presses both on the bodies 43 and on the cross elements 46, to deform them and cause them to expand within their respective seats 40 and 51, so increasing their seal effect. This effect is also increased by the pressure exerted on the bodies 43 and elements 46 by the coupled elements 1, 13 or 15 which tend to close onto them under the action of the pressure of the fluid contained in the modular structure.

It should be noted that each flange 25 comprises a plurality of recesses 55 distributed along its length. As the closure panels 1A, 13A and 15A have, as stated, a shape substantially identical to the shape of the corresponding coupled elements 1, 13 and 15, these closure panels also present flanges 25A shaped as the flanges 25 of said elements. When coupled to the corresponding coupled elements, said flanges 25A lie coplanar to the flanges 25 of these latter elements and the recesses 55 thereof lie in front of those of the corresponding flanges 25A to hence define apertures 58 between the elements 1, 13 and 15 and the superposed panels 1A, 13A and 15A. Tubes, conduits for electrical connections or other similar members can be passed through these apertures.

The closure panels 1A, 13A and 15A are connected to the corresponding coupled elements 1, 13 and 15 by a similar method to the connection between these latter. This method is not described for simplicity, neither are the relative fixing members shown.

Insulation elements 60 (see Figure 6A) such as panels of polystyrene or glass wool, are advantageously positioned in the space between the coupled elements and the corresponding panels.

If the modular structure of the invention is used as a tank, it can comprise a flat element 13 provided with an aperture giving access to the interior compartment 28 of the structure. This aperture is closed by a door 65 associated with the corresponding closure panel 13A; this door rotates about a lateral hinge 66 and

can be locked, by a locking member 67 (for example a padlock as shown in Figure 2), onto a retaining element 68 associated with the door.

Both the coupled elements 1, 13 and 15 and the corresponding closure panels 1A, 13A and 15A are of plastic material (for example high density polyethylene) or of composite material (for example polyester impregnated with carbon fibres or "SMC", resulting in elements and panels which are lightweight, hence facilitating their transport, while at the same time of high mechanical strength.

Various embodiments of the invention have been described. Others are however possible to the expert of the art in the light of the teachings of the present document and are to be considered as falling within the scope of the ensuing claims. For example, a walkway also formed from coupled elements identical or similar to those indicated by 13 in the preceding description can be provided around for example the structure of Figure 6 (usable as an open top tank). Alternatively, as already stated, the structure of the invention can be use as a dwelling unit with its interior compartment well insulated from the outside (by the insulation elements 60) and heated (for example by pipes through which hot or refrigerated water passes, disposed within the apertures 58 and supported by the elements 1, 13, 15 and panels 1A, 13A, 15A fixed together). If the structure of the invention is used as a pool (Figure 8), in the interspace between the panels 1A and 13A and the corresponding elements 1 and 13 which define one side of the structure, a movable cover can be positioned (for example rollable about a support roller rotated by one or more electric actuators also carried within said interspace), in order to cover the structure when not in use, to prevent leaves, insects or the like from entering the water and to maintain the water as clean as possible with time. This cover (and its structure means and electric actuator) can also coexist with an insulation element 60 located in the same interspace.

The illustrated structures have a substantially regular shape when used as tanks for containing water (Figures 1, 2, 5 and 6); however because of the modularity of their constituent components they can be of any other shape, for example annular shape, L-shape or other shapes.

By virtue of the invention, the modular structure can be easily and quickly assembled. This is achieved by firstly connecting the elements 1, 13 and 15

(and superposing on them any required panels 1A, 13A and 15A) together mechanically, then providing the necessary fluid tightness along the connecting regions of these elements. This latter operation is effected from the inside of the structure after it has been assembled. Assembly does not require welding, but only the tightening of screws or bolts against U-pieces which sandwich together the flanges of two coupled elements 1, 13 and 15 (and of the closure panels).